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HOW ANCIENT SECRETS YIELD TO MODERN SCIENCE

STAINED GLASS

TWO VANISHED BIRDS

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HOW ANCIENT SECRETS YIELD TO MODERN SCIENCE

Complex new instruments can disclose how antiquities were made or altered—and even detect forgeries 2400 years old

R. M. Organ, Curator of Conservation

Antiquities must sometimes be submitted to scientific examination. The reasons for this are numerous but may be divided into two classes: first, as one means of establishing the authenticity of an object, and, second, as a way of establishing its physical condition and chemical composition before devising measures for its conservation or restoration. This short article will consider only the first of these, and that briefly.

Ideally, any object worthy of a place in an archaeological study collection will have been obtained from a scientifically controlled excavation; as a result, its approximate date will be known from evidence associated with its discovery. Unfortunately this is not always true. The majority of objects in the ROM collections were obtained either before archaeological techniques had reached their present advanced state, or through dealers. Ordinarily an expert can identify an object whose origins are unknown by comparing points of style; sometimes, however, no sufficiently complete typology has been

developed, and other criteria must be applied. These criteria involve the techniques or the materials used in making the object. In determining them the scientist can be of great value, bringing to bear well known methods of examination or developing new ones to resolve a particular difficulty in attribution. He may use both observation and analysis.

The simplest method of observation is visual examination under the optical miscroscope. Three other important but well-known methods involve ultraviolet fluorescence, infrared reflectance and radiography. Modern improvements allow these methods to be extended to more difficult subjects but essentially they produce morphological information which to the expert is of great value in itself, but usually requires further study of a more analytical nature if its full import is to be realized. Let us consider some examples.

First, let us imagine that ultraviolet fluorescence has disclosed the presence of an area of skilful repair in an object. The value of the object may be less if the repair was made in recent times. We know that the repair was made, or obscured, by some organic material or it would not have fluoresced in ultraviolet light. If we now can remove a fragment of this organic material and determine its infrared absorption spectrum in an infrared spectrometer, we may be able to identify it as epoxy resin. In this event the repair clearly is modern.

Second, let us imagine that X-radiography has disclosed a hard-soldered joint in the hilt of a sword of uncertain provenance. This joint might represent a modern repair, or an original method of manufacture. Now a modern repair will contain one of the standard brazing alloys, whereas an ancient joint may contain copper or some copper alloy different from those used today. In order to determine which solder has been employed we need to analyse it. This may be difficult because the joint will be very thin and very little sample will be available. Perhaps we will not be allowed to take a sample—in this event the problem becomes even more difficult!

Some information about the solder may be obtainable by metallographic means. First we should have to polish to a mirror finish a very small area of the object containing the joint to be examined. Then we would examine it in a metallographic microscope under vertically incident illumination, after applying a small amount of an etching agent to the surface in order to develop the crystal structure of the metal. From only the structure of the solder and of the object itself, we may be able to decide whether the joint was in fact ancient.

By greatly elaborated modern physical apparatus, we may even obtain some information about the chemical composition of these metals with no more than the polished surface to work upon. We would use what is called an electron-probe micro-analyser, and with it we would obtain photographs,

in terms of any particular element we choose, of a small area of the mirror-polished surface. It could be used to show in this case the distribution of tin in a copper-tin solder and to draw curves showing how the composition of the metal changes across the joint. It can also record, for example, the distribution of mercury and arsenic used as sulphide pigments in Chinese lacquer. This instrument may prove of great value in studying ancient silver which has become embrittled and can no longer be annealed by the usual methods.

Analysis serves the museum in many other ways. Illegible Roman coins, for example, can sometimes be dated within 40 to 60 years from a knowledge of their composition. The probability that an object made of glass originated in ancient Egypt may be decided on the basis of the ratio of calcium to magnesium it is found to contain. It has even been stated that we can determine which of the New England mines provided the material for making a particular piece of pottery from that region if we can estimate the content of the trace elements rubidium and caesium. Clearly, the uses of analysis are manifold, and analytical facilities must be provided.

Next, let us consider the practical details. If we know in advance what elements are to be estimated, and if we can obtain a quite large sample, then simple wet chemical analysis may serve. Usually, however, we are not permitted to take a large sample, and sometimes we are not allowed any sample at all. Then, we have to turn from chemistry to physics in order to find a comparatively non-destructive method of analysis. One invaluable tool is optical emission spectrography. This method can yield a permanent record of all the elements, down to a content of about one-thousandth of one per cent, that are present in a sample weighing as little as five milligrams. However, even five milligrams of sample may not be available.

A method that uses no sample and is completely non-destructive makes use of X-ray fluorescence. In principle, a flat area of the antiquity is irradiated with X-radiation. The area then emits secondary X-rays of frequencies representative of the elements present. The relative intensities of these secondary frequencies are recorded on a paper chart and from this an analysis of the area can be calculated after making some corrections. The method, useful though it is, has several disadvantages. The first is that commercially available apparatus is not usually designed to accept very large and irregularly shaped complete antiquities. This difficulty will be largely overcome, however, in an apparatus developed in recent years which will permit any object to be brought up against the working port and will yield an analysis of an area down to a small fraction of a millimetre in diameter. This apparatus will be useful for examining pigments *in situ* and for analyses of enamels and glazes. The second disadvantage of X-ray fluorescence is that the analysis concerns only a very shallow layer on the surface—and in antiquities the

surface has always altered in composition with the passage of time.

Another non-destructive method of analysis that has been applied to metal objects is that of neutron-activation. Here the antiquity is placed for, say, twenty minutes in a flux of neutrons such as may be found in an atomic pile. As a result of this exposure the elements present in the object emit gamma radiations of various energies that fall off in intensity with the passage of time. This radiation is analysed and the result can yield an estimate of the kind and quantity of the elements present in the whole object, not the surface alone. The method has been used to determine the silver content of Greek coins of the sixth and the fourth centuries B.C. One was discovered to have been an ancient forgery.

A final example of an advanced analytical method concerns the mass spectrograph. This instrument can make the best use of a very minute sample. It yields a "spectrum" containing lines representing not only elements but isotopes of the elements present. This has proved particularly useful in the case of the element lead, which happens to contain four major isotopes whose relative abundances vary with the geological age of the mineral deposits from which they were obtained. As a result of work in progress it appears possible to prove that lead found in a particular antiquity did not come from a certain mine, and it may eventually become possible to identify positively areas from which the lead could have come. For example, ancient lead from Tara, in Ireland, has been found to compare with Italian lead, but not with lead from England or Wales. Hence we have an argument favouring the existence of trade between Ireland and Italy. This method can be applied to lead found not as metal but in chemical combination in lead-glass or glazes, in pigments, or even to particles of lead obtained from leaded Chinese bronze. The mass spectrograph can be used in analysis of all elements, not only lead, and could well replace an optical emission spectrograph in a museum laboratory with many fringe benefits.

Enough has now been written to indicate the number and wide scope of the arsenal of investigatory weapons. Each has its own sphere of usefulness in the modern museum laboratory. To a considerable degree its usefulness is proportional to the facility with which it can be employed. In many cases, for example, similar information about a particular antiquity can be obtained by either the slow process of wet chemical analysis or a comparatively rapid spectrographic method. A wet chemical analysis, together with the standardization and replication needed to ensure that the result is worth the effort, may well occupy several weeks. On the other hand a group of three or four spectrographic analyses, with all the checks necessary, need take only one day once calibration curves have been constructed. Of course the capital outlay required differs in the two cases, but in a large museum containing many objects and the possibility of a great amount of investigatory

work, clearly one of the spectrographic analytical techniques offers many advantages over the slower chemical methods.

We now appear to be at a turning point in the history of laboratory services to museums. Hitherto there has been a sharp distinction between conservation and research. On the one hand, conservation has been concerned with the practice of routine methods, admittedly many of them of an advanced or sophisticated character. For lack of facilities, a particular method has been selected largely on the basis of the conservator's long experience and with a minimum of scientific control.

On the other hand, research into specific problems raised by archaeologists and curators has been prosecuted by post-graduate students in various well-equipped institutions, each working on his own problem and perhaps leaving the field of museum interest altogether as soon as his research has been completed. As a result of these isolated researches, conducted on antiquities or on samples begged or borrowed from whoever would lend, we are beginning to have at our disposal a corpus of factual information concerning the materials and methods used to make antiquities in various periods and areas of the world.

Hitherto, such information had to be sought deliberately by prolonged research whenever any particular problem arose. Even now, fundamental research of this nature needs to be intensified, and there is no better place to carry it out than in a museum where study collections already exist.

Now that so much information is already available the individual museum curator, pressed as he is by day-to-day practical problems of cataloguing and exhibition, can begin to hope for a rapid scientific check of the attributions of doubtful objects in his own collections. The curator can obtain this service only from a laboratory that is well equipped and experienced in the use of its apparatus on museum problems, so different from those encountered in industry.

Clearly, the museum laboratory of today should provide scientific services to both conservation and research. It should have a large arsenal of weapons, maintained sharp by routine application to day-to-day problems of restoration so that each is in readiness for use upon the isolated special problem when it is presented.

An even more efficient use of expensive facilities and skilled staff can be made when a laboratory concurrently carries out research programmes based upon the museum collections. Then conservation and research can proceed side by side, each fertilizing the other. At present there are very few, if any, archaeological museum laboratories in the world that operate in this balanced manner, almost every one being heavily biassed toward either research or routine conservation. It is to be hoped that the conservation department at the ROM will become a well-balanced unit.

STAINED GLASS IN AUSTRIA

The historical setting of a new ROM *acquisition*

H. Hickl-Szabo, Assistant Curator, European Department

The Royal Ontario Museum, with the help of the Laidlaw Foundation and other generous friends, has acquired for the European Department a panel from a late mediaeval stained glass window. It is documented as coming from the early fourteenth century parish church in St. Leonhard, a small spa in the Lavan valley in Carinthia, Austria.

The panel shows the full length figure of St. Catherine of Alexandria stepping out of a Gothic canopy, its four arches shown in perspective. The spandrels of the front arch are decorated in schwarzlot technique with Gothic tracery, the sides are the front columns of the canopy, and at the bottom is a simplified version of a mediaeval castle, perhaps intended to be that of her father, King Maximian. St. Catherine holds in her left arm her attribute, the wheel, and in her right hand a sword. The colours are black, light blue, dark blue, violet, a honey-coloured gold, green, red and white. There is surprisingly little corrosion, and this implies that the panel was in a healthy climate for several centuries. It is also free of cracks and breakage, and its condition is far above average.

This panel and twelve others appeared this spring at the sale of the Stockett Collection in London. It is one of eight mentioned by Walter Frödl as having formed window No. 6 in the North Choir in the church in St. Leonhard, and as having been on the left in the bottom row. While Frödl has admirably described the wealth of stained glass in this church and in many other churches and monasteries in Carinthia, he unfortunately never saw these eight panels, and had to rely on second-hand information about them; he was satisfied, however, that the two panels in the bottom row did not belong to the same cycle as the other six. The "St. Agnes" panel, said to have been on the right of ours in the bottom row, differs from it and from the six above, and does not concern us here.

Frödl's suggestion that the "St. Catherine" panel does not belong to the cycle of the other stained glass in the church is quickly verified by comparing its obvious characteristics with those of the other group. Apart from a small difference in size—which in itself may be meaningless—we must note (a) a small discrepancy in the colour scheme (the emphasis on green is much greater in the other panels than in ours), (b) the architectural framework of

From the left:

Magdalenen panel (1150)

Panel of the Foolish Virgin, Friesach (c. 1270)

Annunciation panel, St. Leonhard i/L (1330)

The ROM's new acquisition, St. Catherine, from St. Leonhard i/L (c. 1400)

the "St. Catherine" panel does not match the geometric borders of the other group, and (c) in style the "St. Catherine" panel is later, as will be proved, than the other stained glass in the church.

While in many other countries the development of styles forms a more or less uninterrupted chain, in which each period is linked to the following and the previous one, the picture is different in Austria, where the individual stages of progress are not connected with each other. One reason, though not the only one, will come to light if we illustrate a number of relevant examples: that is, the extremely slow and sporadic infiltration of outside inspiration and its translation into a craft so specialized as stained glass.

The documented history of stained glass in what is now Austria goes back to 1150. Of this date is the Magdalenen panel from Weitensfeld near Gurk, and its generally accepted prototype, the Antiphonary of St. Peter from the Codex Salzburgensis. Although the style of both shows Cluniac influence

with a strong current of Byzantine, it should be noted that the prototype as well as the panel were made in Salzburg. The panel stands in splendid isolation, surpassing in quality and sophistication even the contemporary "Apostle" panels in Regensburg.

By the beginning of the thirteenth century the Alpine area seems to have become a melting pot of styles, not all of which put down roots at once or grew at the same rate. Communications did exist, chiefly through the church, but they were limited, and outside influences filtered in only sporadically.

One of the most important manifestations of a stylistic infiltration is the fresco in the west doorway of the Cathedral in Gurk, dated about 1265–70, the importance of which, not only for Austria but for the whole world, is established. It shows the Italian influence brought in by the Dominicans, but it is definitely a Carinthian monument and the prototype of the panels of the "Wise and Foolish Virgins" of about 1270 in the church of St. Bartolo-

meus in Friesach. These are undoubtedly the best examples of the "Zackenstil", peculiar to the Alpine area, and the second stage in the development of Austrian stained glass. How little this stage is connected with the previous one is evident, although these panels too came from a Salzburg workshop.

The roots of the third stage go back to the year 1181, which is considerably earlier than those of the previous stage, but there is no indication that the style flowered before 1330. This slow development illustrates the length of time that can elapse before an infiltrating style ripens in an Alpine area. Of special interest to us is the fact that this new development leads directly to the corpus of stained glass in the church at St. Leonhard, although not to our "St. Catherine". 1181 was the year in which Nicholas of Verdun made what the world considers his *magnum opus*, the enamels of Klosterneuburg, originally the decoration of a type of pulpit called an Ambo. The work was commissioned by Werner, Abbot from 1167 till 1194, and his was the spiritual concept of the enamels executed by Master Nicholas. An Ambo, however, though itself conspicuous, does not display decorative details to advantage, and this may be one reason why the work did not at once inspire other craftsmen. Some time between 1322 and 1331 the monastery was destroyed by fire; it was rebuilt by Abbot Stephan von Sierndorf, and probably at this time the enamels were reset to form the so-called Klosterneuburg Altar. Only then was their impact on other crafts felt. Their stylistic influence on stained glass can be seen directly in the Ambulatory of Klosterneuburg in the panel of the "Birth of Isaac" (about 1330), and in the more provincial, indeed rustic, "Warning to Joseph" panel of similar date in Annaberg. The latter, and most of the panels in St. Leonhard, including the "Annunciation", were made in the Judenburg workshop, always provincial, and catering more and more to the rustic taste. In the main their stylistic standard is far below that of the Klosterneuburg prototype, proving that deterioration has taken place, yet the "Annunciation" and other panels in the church quite clearly derive from it, with their clarity of line and geometric borders, despite the predominant Alpine character. There is no denying the fact that the prototype was indirectly a western import, but in the time lapse of almost a hundred and fifty years it had been absorbed into the Alpine concept, which at that stage had relapsed into the realm of the Primitive, which recurring in the fourteenth century, hovers between the Symbolic and the Humanistic. It had lost subtlety and the power of communication.

Between 1385 and 1420 a new stage is reached in the Ducal workshop in Vienna. This again shows no links with the previous stages, but is related to contemporary work in Bohemia, such as sculpture, graphics and paintings, and it may have drawn inspiration from middle and later fourteenth century sculpture, painting and even stained glass of the Rhine area. Our panel must

be ascribed to this workshop on comparative grounds, the closest examples being the ones in the Ducal chapel in St. Stephan's in Vienna, about sixty panels in the Cistercian Monastery in Victring, most interesting to us because of their location so close to St. Leonhard, and for closer dating purposes, the "Annunciation" panel (about 1400) in the Freisinger chapel in Klosterneuburg. While the Cistercian rule originally forbade the use of the human figure in art "Vitreae albae fiant, sine crucibus et picturis" (the windows shall be white, without crosses and paintings—meaning without figure decoration), by this time the rule was seldom observed. Stylistically, the common denominator of all these examples, including our own, is courtly elegance, displaying the iconography in a most decorative manner; technically, it is predominantly the capacity to show architectural devices, such as canopies, in perspective, lending a strong three-dimensionality to the scene.

It is possible to explain the presence in the church at St. Leonhard of an isolated example such as our "St. Catherine" panel by referring to the close stylistic relation of the rather similar panels in Victring, but this is not the only explanation. The Victring panels were made in Vienna, as far from Victring as from St. Leonhard, which is also a long distance from Judenburg. We know, however, that a wealthy merchant of Judenburg, Heinrich Croph, and his wife Künigunde, were the donors of window No. 6, and it is generally assumed that they had a profitable business connection with St. Leonhard and gave the stained glass to the church to show their gratitude. The stylistic relationship of the "St. Catherine" panel to those at Victring is proof that they came from a common workshop; the presence of our panel in the window suggests that it, like the six above, was a gift, ordered by an unknown merchant in Vienna.

Looking at the style of our window we can say that it was made fifty to sixty years later than the Croph gift. At some time window No. 6 must have been damaged to such an extent that two panels had to be replaced. One of the two replacements, the "St. Agnes" panel briefly mentioned above, is quite obviously from the Judenburg workshop, but either slightly earlier or contemporary with the six above. It is slightly different in size and perhaps taken from a window which was being blocked up. The six upper panels all depict male Saints, and there must have been a general resetting in order to keep the two panels of female Saints in one area, since the "St. George" panel, immediately above the "St. Agnes", has a straight lower border and was presumably originally in the bottom row.

The question now is when did this rearrangement take place? According to the church archives both panels of female Saints had been in this window for at least a hundred and fifty years. While corrosion is evident in the stained glass at Victring, St. Stephan's and Klosterneuburg, the windows in St. Leonhard, including the "St. Catherine" panel, have been protected by the

high altitude and dry climate, so that one is inclined to believe that our panel was *in situ* for nearly as long as the other panels in this window. We therefore feel justified in suggesting that the replacement took place not many years after the installation of the other six panels, and that the "St. Catherine" panel was orderd by an unknown donor about 1400 for this special purpose. The fact that the Judenburg workshop had almost ceased to exist by that time makes it more logical that the donor commissioned the panel in Vienna.

TWO VANISHED BIRDS

The Museum obtains long-sought specimens of the great auk and Labrador duck

J. L. Baillie, Assistant Curator of Ornithology

Although possessing the finest and most representative collection of birds in Canada, the ROM, until recently, did not own a great auk (*Pinguinus impennis*) or a Labrador duck (*Camptorhynchus labradorium*), both of which have long been extinct. The late Paul Hahn, a patron of the ROM with a particular interest in extinct species, decided in 1957 that any efforts to obtain one of each for the Museum must be preceded by an inventory of the existing specimens. A questionnaire was prepared, eliciting information on the whereabouts of all the extant great auks and Labrador ducks, and five other species of North American extinct or near-extinct birds—passenger pigeons, Eskimo curlews, ivory-billed woodpeckers, whooping cranes, and Carolina parakeets. This was sent to all natural history museums and private collectors that might be expected to possess specimens.

During the next five years more than 1,000 replies came back, listing the holdings of the various collections. Not satisfied with this, Mr. Hahn, with characteristic initiative, followed up each completed questionnaire with a second request for whatever data there were for each specimen. Mr. Hahn died at age 87 in 1962, but the results of his labours were published posthumously by the ROM in *Where is that Vanished Bird?* which should be a boon to curators the world over.

The possibility of obtaining a great auk and a Labrador duck seemed enhanced when it became evident that there were, in fact, 78 great auks and 54 Labrador ducks preserved in collections, but there was no great auk listed in any Canadian collection, and only two Labrador ducks, in McGill and Dalhousie Universities.

Letters were then addressed to some of the owners of great auks and Labrador ducks, with the idea of making them an offer. This initial attempt proved unsuccessful with respect to purchase. However, the approximate value of the birds was established. Many said their birds were not for sale or exchange; others hinted that they might be interested if a high enough bid were to be made.

The situation remained unchanged until August, 1964, when a conversation the writer had with Dr. Ralph S. Palmer, New York State Zoologist, raised our hopes. He assured us that the great auk and the Labrador duck listed as owned by Vassar College, Poughkeepsie, New York, might be purchased. It was, in fact, an extremely delicate matter, as Vassar had consistently resisted all opportunities to dispose of their birds ever since they were received as a gift from Jacob Post Giraud, Jr. in 1867. Dr. Palmer, formerly on the faculty at Vassar, seemed the logical person to make further enquiries on our behalf. He opened negotiations at the start of the school term in September. The two specimens had been housed since October 17, 1921 at the American Museum of Natural History in New York, through a permanent loan arrangement concluded with Vassar by the late Dr. Leonard C. Sanford. It was just coincidental that Dr. Palmer was also well known to the curator of ornithology at the American Museum.

At Toronto, we initiated a drive for funds, as the purchase of these treasures could scarcely be made from the ROM's regular budget for specimens. Less than a year after our first conversation with our able agent, we had collected enough funds to buy the birds, had both the consent of Vassar College and the approval of the American Museum, and had the birds themselves brought safely to Toronto.

Altogether, about 200 friends of the ROM contributed to the fund, including major contributions from the Canadian National Sportsmen's Show, and the McLean and Atkinson Charitable Foundations.

GREAT AUK

The Vassar great auk proved to be of great historical interest, being the specimen once owned by John James Audubon, and used by him as the subject of his painting in 1836 and published in his famous double elephant-folio edition of 1838 of *Birds of America*. Audubon had bought the auk in London, England, before 1836, and it was the only specimen he ever possessed.

He presented the bird to his friend, Jacob Post Giraud, Jr., and it went to Vassar in 1867 with the rest of Giraud's collection of 800 mounted North American birds. Giraud was the author of *The Birds of Long Island* (1844), which was considered "the best piece of local ornithological work that had appeared up to that time". In 1841, his collection was thought by Professor

Spencer F. Baird to be "the finest collection of North American birds that he had ever seen".

When the American Museum of Natural History received the bird in 1921 for safekeeping, part of their arrangement with Vassar was to have the specimen remounted and placed in an air-tight case. This was done by George Nelson, taxidermist of the Museum of Comparative Zoology, Cambridge, Massachusetts, according to Dr. Palmer. When the skin was removed, the mount was found to be filled with German newspapers, indicating its Old World origin.

Concerning the earlier history of the specimen, we know nothing. A. Newton has stated that "It is pretty evident that most of the specimens of Great Auk and its eggs, which now exist in collections, were obtained from Eldey (Island, Iceland) between the years 1830 and 1844". According to W. Ley, approximately 72 great auks were exported from Iceland for museums and dealers during that period, a large portion of them reaching taxidermists in Germany, Holland and England, through Copenhagen, Denmark. Considering the fact that only 78 skins exist, it would appear that Iceland was in fact the source of most of the known specimens.

J. Cassin stated incorrectly in 1860 that Audubon's great auk had been "obtained on the banks of Newfoundland". As previously indicated this seems unlikely, as it had been bought in England and was stuffed with German papers. In addition, Audubon indicated that the only account he knew of a great auk taken on the American side of the Atlantic, was of one bird caught on the Newfoundland bank by Henry Havell, kept alive for a few days, and then released.

All specimens of certain New World origin are of skeletal remains only. The apparent lack of a skin from the New World is interesting in view of J. Steenstrup's statement in 1855 that at no place in the world, within historic times "has it been seen in so great abundance as on the islands off Newfoundland".

The breeding range of the great auk was on islands on both sides of the north Atlantic (notably on Funk Island, off the northeastern coast of Newfoundland). It wintered as far south as the Bay of Biscay (Gibraltar, according to J. C. Greenway) and Florida. The last individual was killed on June 3 (4th, according to Ley) 1844 on Eldey Island, off the southwestern tip of Iceland. Some idea of their former abundance on Funk Island may be inferred from the account of F. A. Lucas, who visited the island in the summer of 1887 for the United States National Museum. In two days hard work he and his party exhumed "thousands of bones", including more than 1,400 humeri.

According to Townsend, "The fundamental cause of the extinction of the great auk was the systematic onslaught made for various reasons by civilized

man . . . primarily for food, later for bait, for its fat and its feathers, and last of all, when it was doomed to extinction, the finishing blow was put by collectors". Historically man's ruthless and wholesale persecution of these helpless birds dates from 1534, when Jacques Cartier's men killed more than 1,000 in one day on Funk Island, to 1813, when Captain Peter Hansen's schooner-load of soldiers collected eggs by 'boat-loads' on Geirfuglasker. As indicated, eggs were eaten, and also the birds' bodies salted down for winter use, in lieu of salt pork. The feathers, utilized extensively for feather-beds and pillows, were removed from the flightless birds by scalding them in boiling water in huge kettles, or try-pots. As Funk Island was devoid of trees, the bodies of the birds, minus feathers, were used as fuel for the kettles. It is also on record that the Micmac Indians used great auks' gullets as quivers for their arrows. Even Nature herself appeared to lend a hand in the ultimate disappearance of the species, when in 1830 a submarine volcanic eruption off Iceland caused the skerry already mentioned, Geirfuglasker (the rock of the great auk), to disappear below the surface of the ocean.

LABRADOR DUCK

The specimen of the Labrador duck is of an adult male. As with the great auk, it belonged to Jacob Post Giraud, Jr., of New York. The bird went to Vassar with the rest of the Giraud collection in 1867, and in 1921 it was transferred on a loan arrangement to the American Museum of Natural History. At that time, it was placed in a matching glass, bronze-trimmed case, by George Nelson, at Cambridge, Massachusetts, and was apparently, as with the great auk, remounted by this taxidermist at that time. At the American Museum of Natural History it has been kept in a locked safe with the great auk for 44 years, in the Department of Ornithology.

G. D. Rowley claimed in 1877 that the bird was shot on the south side of Long Island, New York, about 1841. W. Dutcher said in 1891 that there is no proof of this, although admitting that "the greater portion of Mr. Giraud's life-long ornithological work was done on Long Island". J. C. Phillips says "Most of the specimens still extant in museums appear to have come from the vicinity of Long Island Sound".

The Labrador duck occurred only along the New World side of the north Atlantic, from southern Labrador to Chesapeake Bay, inland at least occasionally to Montreal and Philadelphia. The last one was shot on Long Island on December 12, 1875.

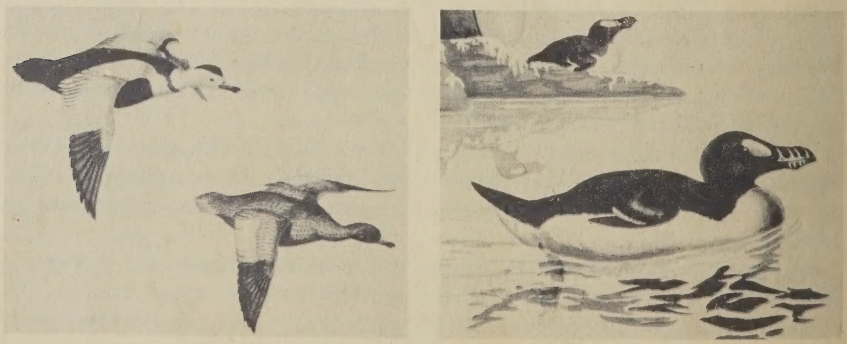
The published opinion of several authorities to the contrary, the extermination of this species evidently was not entirely brought about through the agency of man, as was the case with the great auk. Various descriptions of its flesh are unflattering—"not considered a delicacy", "strong, unsavory", and "dry and fishy".

It was not hunted extensively although between 1840 and 1870 a considerable number were said to be found hanging for sale in the New York and Boston markets. Often, however, they would be left hanging until they rotted, particularly if other more desirable species were obtainable.

Dutcher notes that "its familiar haunts were the sandbars where the water was shoal enough for them to pursue their favorite food, small shell-fish", and Outram Bangs suggested to Phillips that a likely cause of its extermination would be to suppose it "had very specialized food habits and that changes in the molluscan fauna, brought about by increased population along our coast, may have proved disastrous. Such changes in minute shell-fish are known to have taken place".

Greenway warns that any observations on the causes of its disappearance must necessarily be speculative, due to the limited written record concerning the habits of the species. He quotes Bangs to the effect that the lamellae of the Labrador duck's bill indicate specialized food habits. He thinks that it had a rather small, island habitat, which was probably raided by humans during the breeding season, and cites the case of the common eiders (*Somateria mollissima*) disappearing from the Maine coast as breeding birds as a similar phenomenon. Uncontrolled shooting and other miscellaneous forms of molestation reduced these eiders to a single pair by 1907. The local Audubon Society stepped in, placed a warden at the nest-site, and opened a campaign which resulted in a law prohibiting the shooting of the species. By 1958, the eiders were nesting on more than fifty barren islets off the Maine coast.

Although estimates of the former abundance of the Labrador duck range from "common" to "always rare", it is a fact that there is not a single record of its nest having been observed by a competent naturalist. Audubon never saw the bird alive, and A. C. Bent concluded that it never was a numerous species, and never was shot in very large numbers.



LABRADOR DUCK GREAT AUK

(*Drawings by T. M. Shortt*)